

## HYDRAULIC POWER STEERING SYSTEM

**FIELD OF THE INVENTION**

The **present** invention relates to a hydraulic power steering system for a vehicle, ~~in particular~~ **e.g.**, an electrohydraulic power steering system for a motor vehicle, ~~according to the preamble of~~  
5 ~~claim 1.~~

**BACKGROUND INFORMATION**

Hydraulic or electrohydraulic power steering systems for motor vehicles having a servo valve, which is ~~embodied~~ **arranged** as a  
10 rotary slide arrangement and whose control parts - rotary slide sleeve and rotary slide - which are rotatable relative to one another are drive-coupled to one another by ~~means of~~ a torsion element which sets the control parts in a normal position relative to one another, and having a steering gear which is arranged, for  
15 the purpose of transmitting drive, between one of the control parts and steered vehicle wheels and is drive-connected directly or indirectly to a hydraulic servo cylinder which is controlled by the servo valve, are ~~known~~ **conventional**.

20 A piston rod of the servo cylinder is connected to one or more steerable wheels of the vehicle in a ~~known way~~ **conventional manner** via tie rods and steering levers. A toothed rack, which meshes with a pinion of an electric servo motor or a pinion of a mechanical steering shaft connection to a steering handle, is connected in  
25 series with the piston rod of the servo cylinder (cf. ~~DE~~ **German Published Patent Application No. 195 41 749 C1** or **EP-0708 European Published Patent Application No. 0 708 011 A2**).

The series connection of the piston rod and the toothed rack results  
30 in a large installation length of an actuator for an electrohydraulic power steering system. As a result, only relatively short tie rods are possible, which lead to unfavorable  
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kinematics of an axle, to large steering inclination angles and sweep angles of the tie rods and to high loading, in particular in commercial motor vehicles, of an electrohydraulic power steering system and its actuator. In addition, electrohydraulic power steering systems of said this type are designed, in terms of their steering power, for the respective vehicle in which they are used, and are somewhat inflexible in use.

#### SUMMARY

The Example embodiments of the present invention is based on the object of providing may provide an electrohydraulic power steering system which is as compactly designed arranged as possible in the region of its actuator and is suitable for different classes of vehicle.

~~The object is achieved by means of an electrohydraulic power steering system having the features of claim 1.~~

An electrohydraulic power steering system, which is suitable in particular, e.g., for a commercial motor vehicle, and whose actuator is of short design arrangement and can may be modularly adapted to different power or weight classes of vehicles, is provided in that the piston rod of the servo cylinder and the rack or toothed rack which is axially displaced by the electric servo motor are arranged parallel to one another, and the rack or toothed rack and the piston rod act on an addition member which is in turn operatively connected to the steerable wheel. The rack of the electric servo motor and the piston rod act on the addition member simultaneously and in the same direction.

~~Preferred embodiments can be gathered from the subclaims.~~

The rack and the piston rod can may be articulatedly connected to the addition member. The rack or toothed rack is may however preferably be fixedly connected to the addition member. The piston

rod ~~is preferably likewise~~ may be fixedly connected to the addition member, as a result of which the rack, driven by the electric servo motor, and the piston rod perform an axial movement and the addition member, which is embodied arranged as a yoke, is linearly  
5 displaced.

Different arrangements of the electric servo motor with the rack, of the servo valve, of the servo cylinder and of their operative connection to one another ~~can~~ may also be expedient provided. In  
10 ~~a first, preferred~~ an example embodiment, the electric servo motor thus acts on a control part, ~~in particular~~ e.g., a rotary slide, of the servo valve via a step-down gearing. The control part is ~~in turn~~ rotatably operatively connected to a drive output member, such as a gearwheel which meshes with a recirculating ball nut or  
15 a pinion which meshes with a toothed rack. When it rotates, the recirculating ball nut causes, in a ~~known way~~ conventional manner, an axial displacement of the rack which is embodied arranged as a spindle and ~~in turn~~ acts on the addition member.

20 It ~~can~~ may be expedient provided for the control part of the servo valve to be rotated not by the electric servo motor, but rather mechanically by a steering shaft with a steering handle, in order to actuate the servo cylinder.

25 The Example embodiments of the present invention ~~will now be~~ are described in more detail ~~on the basis of an exemplary embodiment and represented on the basis of~~ below with reference to the appended drawings Figures.

### 30 BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 ~~shows~~ is a schematic longitudinal section cross-sectional view of an actuator of a ~~first~~ an electrohydraulic power steering system.

Figure 2 ~~shows~~ is a further longitudinal ~~section~~ cross-sectional  
view through an actuator of an electrohydraulic power steering  
system<sub>7</sub>.

5 Figure 3 ~~shows~~ is a further longitudinal ~~section~~ cross-sectional  
view through an actuator of an electrohydraulic power steering  
system<sub>7</sub>.

Figure 4 ~~shows~~ is a schematic longitudinal ~~section~~ cross-sectional  
10 view through an electrohydraulic power steering system in the form  
of a double pinion steering system<sub>7</sub>.

Figure 5 ~~shows~~ is a schematic longitudinal ~~section~~ cross-sectional  
view through an electrohydraulic power steering system which is  
15 ~~embedded~~ arranged as a superposition steering system.

#### DETAILED DESCRIPTION

Figure 1 ~~shows~~ is a schematic longitudinal ~~section~~ cross-sectional  
view of a linear wheel actuator 19 of a hydraulic power steering  
20 system 1 with electromotive assistance of the actuating power of  
a servo cylinder 4. Two series-connected electric servo motors 6  
drive via a gearing 9 a control part 10 of a servo valve 2, ~~said~~  
the control part being ~~embedded~~ arranged as a rotary slide and being  
mounted in a coaxial rotary slide sleeve 21. The servo valve 2 is  
25 connected to a pressure medium container ~~(not illustrated)~~ and a  
hydraulic pump, wherein the pressure medium container is connected,  
e.g., in a conventional manner ~~known per se~~, to a low-pressure  
connection, and the hydraulic pump is connected to a high-pressure  
connection. A first working space 23 and a second working space  
30 23' of the servo cylinder 4 are fluidically connected to  
connections ~~(not illustrated)~~ of the servo valve 2, and are in each  
case alternately pressurized with pressure medium for the purpose  
of displacing a dual-acting piston/piston-rod arrangement in the  
servo cylinder 4. The servo valve 2 has an open center, that is  
35 to say all the connections communicate with one another when the

control part 10 and the rotary slide sleeve 21 assume a central position relative to one another. The control part 10 and the rotary slide sleeve 21 are connected to one another by ~~means of~~ a torsion bar which is arranged in an axial bore of the parts and attempts  
5 to keep the control part 10 and the rotary slide sleeve 21 in their central position relative to one another.

The control part 10 carries a drive output member 11 which is embodied arranged as a gearwheel 12, as a steering nut 13 or as  
10 a recirculating ball nut 14 and rotates around, and drives, the rack 7. An addition member 8 is fixed to one end of the rack 7 and is additionally fixedly connected to one end 22 of the piston rod 3, so that the electric servo motors 6 drive both the servo valve 2 for the purpose of actuating the servo cylinder 4, and also the  
15 rack 7 via the recirculating ball nut 14. In the exemplary embodiments ~~shown~~ illustrated in figures Figures 1 to 5, the addition member 8 connects the rack 7 and the piston rod 3 to one another at right angles. The rack 7 and the piston rod 3 are arranged parallel to one another and without longitudinal offset,  
20 and jointly act on the addition member 8 which fixedly connects the two and is embodied arranged as a yoke 24. The parallel-arrangement of the rack 7 with the servo cylinder 4 results in a short ~~design~~ arrangement of the wheel actuator 19 and of the electrohydraulic power steering system.

25 The electrohydraulic power steering systems ~~shown~~ illustrated in a schematic longitudinal ~~section~~ cross-sections in figures Figures 2 and 3 are of identical arrangement with identical coupling of the rack 7 and the piston rod 3 to the addition member 8. The  
30 electric servo motor 6 drives the control part 10 via a gearing 9, ~~said~~ the control part 10 ~~in turn~~ acting on the rack 7 via a drive output member 11 for the purpose of axially displacing said rack 7 (cf. figure 2). A steering shaft 16 is rotationally fixedly connected to the control part 10. In ~~figure~~ Figure 3, the steering  
35 shaft 16 drives the control part 10 of the servo valve 2 which acts

on the rack 7 via a drive output member 11 which is ~~embodied~~ arranged as a pinion 15. A step-up gearing 9 is arranged, with the electric servo motor 6, between the control part 10 and the drive output member 11, ~~said~~ the electric servo motor 6 acting on the drive output member 11.

Figures 4 and 5 ~~illustrate~~ are schematic longitudinal ~~sections~~ cross-sectional views through an electrohydraulic power steering system. In ~~figure~~ Figure 4, the electric servo motor 6 acts on the rack 7 via a gearing 18, while the servo valve 2 and its control part 10 are rotationally fixedly connected to the steering shaft 16 and act on the rack 7 via the drive output member 11 (double pinion steering system).

In ~~figure~~ Figure 5, the electric servo motor 6 acts on the drive output member and the rack via a superposition gearing 17 between the servo valve 2 and the drive output member 11.

Abstract

**ABSTRACT**

The invention relates to a A hydraulic power steering system (1) for a vehicle, in particular e.g., an electrohydraulic power steering system for a motor vehicle, ~~having~~ includes a servo valve (2), the relative movement of whose control parts actuates a piston rod (3) of a servo cylinder (4) and changes at least one steering angle ( $\beta$ ) of a wheel (5) which is operatively connected to the piston rod (3). The power steering system (1) additionally has an electric servo motor (6) which drives a rack (7) with the servo cylinder (4) for the purpose of adjusting the steering angle of the wheel (5) in the same direction.

In order to provide an electrohydraulic power steering system which is as compactly ~~designed~~ arranged as possible in the region of its actuator and ~~can~~ may be used flexibly for different classes of vehicle, it is provided ~~according to the invention~~ to combine the action of the rack (7) and the piston rod (3) of the servo cylinder (4), in a parallel arrangement with one another, on an addition member (8) for the purpose of jointly adjusting the steering angle of the wheel (5).

~~List of Reference Numbers~~

**LIST OF REFERENCE CHARACTERS**

1	Hydraulic power steering system
2	Servo valve
3	Piston rod
4	Servo cylinder
5	Wheel
6	Servo motor, electric
7	Rack
8	Addition member
9	Gearing
10	Control part
11	Drive output member
12	Gearwheel
13	Steering nut
14	Recirculating ball nut
15	Pinion
16	Steering shaft
17	Superposition gearing
18	Gearing
19	Linear wheel actuator
20	Rotary slide
21	Rotary slide sleeve
22	End
23, 23'	Working space
24	Yoke
$\beta$	Steering angle